

Transformation-Scale Waves

Navigation
Program



Model Background: STWAVE

Jane McKee Smith
Coastal and Hydraulics
Laboratory



Wave Modeling Technology

Transformation-Scale Waves

Navigation
Program



Generation Scale

WISWAVE & WAM

**Transformation
Scale**

STWAVE & SWAN

Local Scale

CGWAVE & BOUSS-2D



Outline

Navigation Program



- Assumptions
 - What's in STWAVE
 - What isn't
- Model Input
- Model Output



Model Processes

Navigation
Program



- Refraction & shoaling
- Wave-current interaction
- Diffraction (simple)
- Wave growth and white capping
- Depth- and steepness-induced breaking





Refraction
Shoaling
Breaking

Shinnecock Inlet, NY
1940



STWAVE Governing Equations

Transformation-Scale Waves

Navigation
Program



- Wave Ray
- Conservation of Wave Action
- Simplified Diffraction
- Wave Growth
 - Wind input
 - Nonlinear transfers to low frequencies
 - Dissipation at high frequencies
- Shallow-Water Breaking



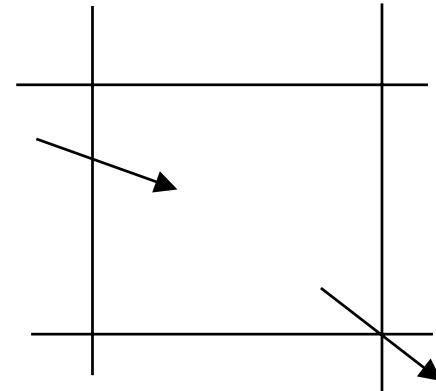
Conservation of Wave Action

Transformation-Scale Waves

Navigation
Program



- Along a wave ray
- Steady state
- Spectral

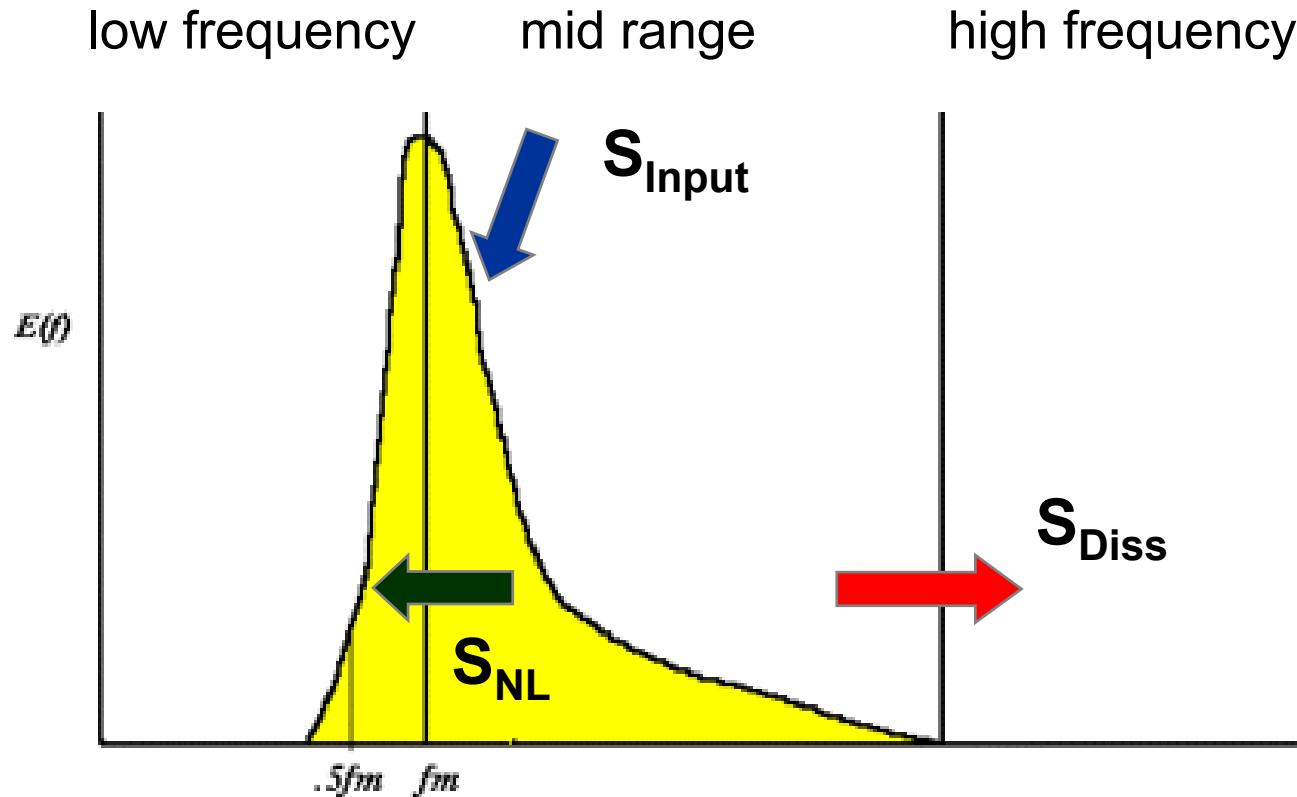


$$(C_{ga})_i \frac{\partial}{\partial x_i} \frac{C_a C_{ga} \cos(\mu - \alpha) E}{\omega_r} = \sum \frac{S}{\omega_r}$$



Generation & Dissipation

Navigation
Program



Shallow-Water Breaking

Navigation
Program



- **Dissipation**

- Empirically based
- Function of height, depth, period, steepness, slope, ...

$$H_{mo_{max}} = 0.1L \tanh kd$$





Model Assumptions

- Linear refraction & shoaling
- Mild slope
- Negligible bottom friction
- Homogeneous offshore waves
- Steady waves, currents, winds
- Depth-uniform current
- Finite difference (square grid cells)



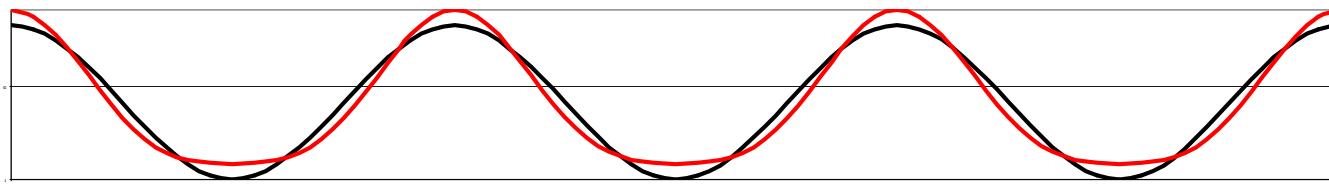
Linear Refraction & Shoaling

Transformation-Scale Waves

Navigation
Program



- Linear dispersion equation
 - Wavelength = f(period, depth, current)
 - Celerity in action balance
 - Celerity in ray equation
- Sine waves
 - Calculation of wave energy

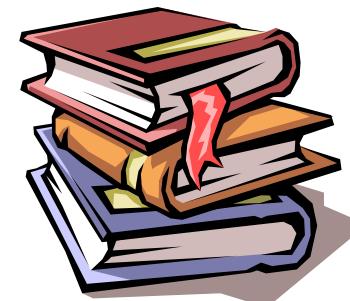
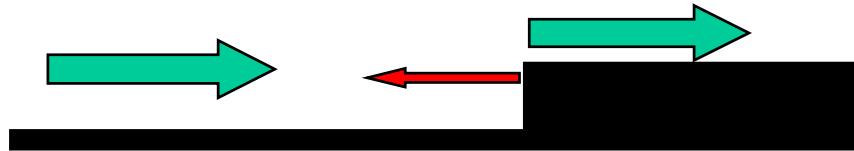


Bed Interactions

Navigation Program



- Mild slope
 - No reflections from bottom
 - No reflections off structures
- Negligible friction
 - Small domain
 - Little guidance



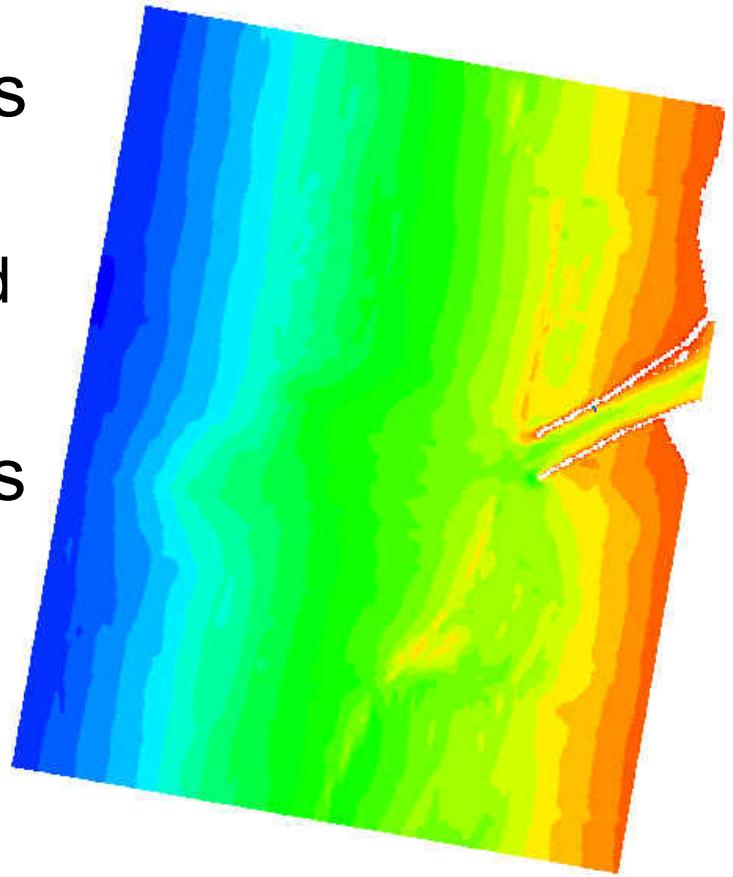
Homogeneous & Steady Forcing

Transformation-Scale Waves

Navigation Program



- Homogeneous offshore waves
 - Domain small ~10's km
 - Important bathymetry within grid
 - Nesting option (variable input)
- Steady waves, currents, winds
 - Relative to propagation time across the grid

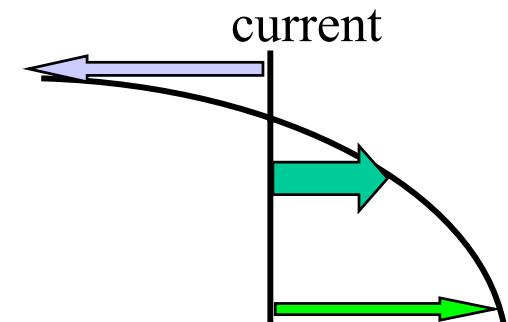


Currents

Navigation Program



- Depth-uniform current
 - Depth-integrated ADCIRC current
 - Shear modifies interactions
- Waves do not change currents
 - One-way interactions

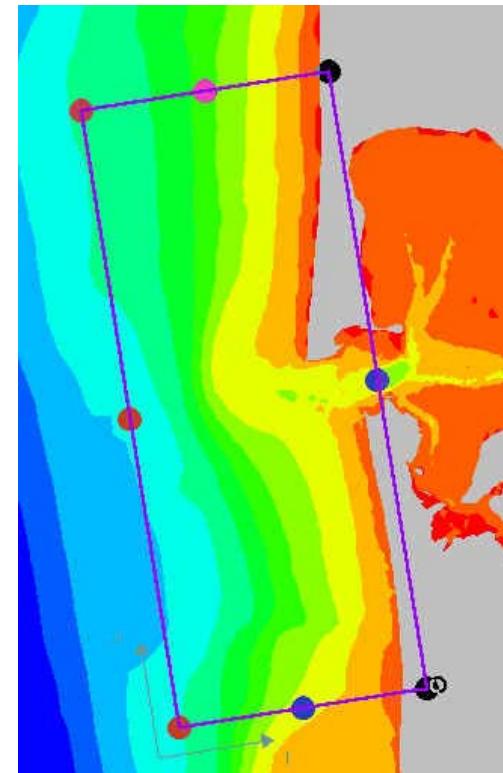


Navigation Program



Model Input

- Required:
 - Model parameters
 - Incident wave spectrum
 - Bathymetry on regular grid
- Optional:
 - Current
 - Wind
 - Tide



Navigation Program

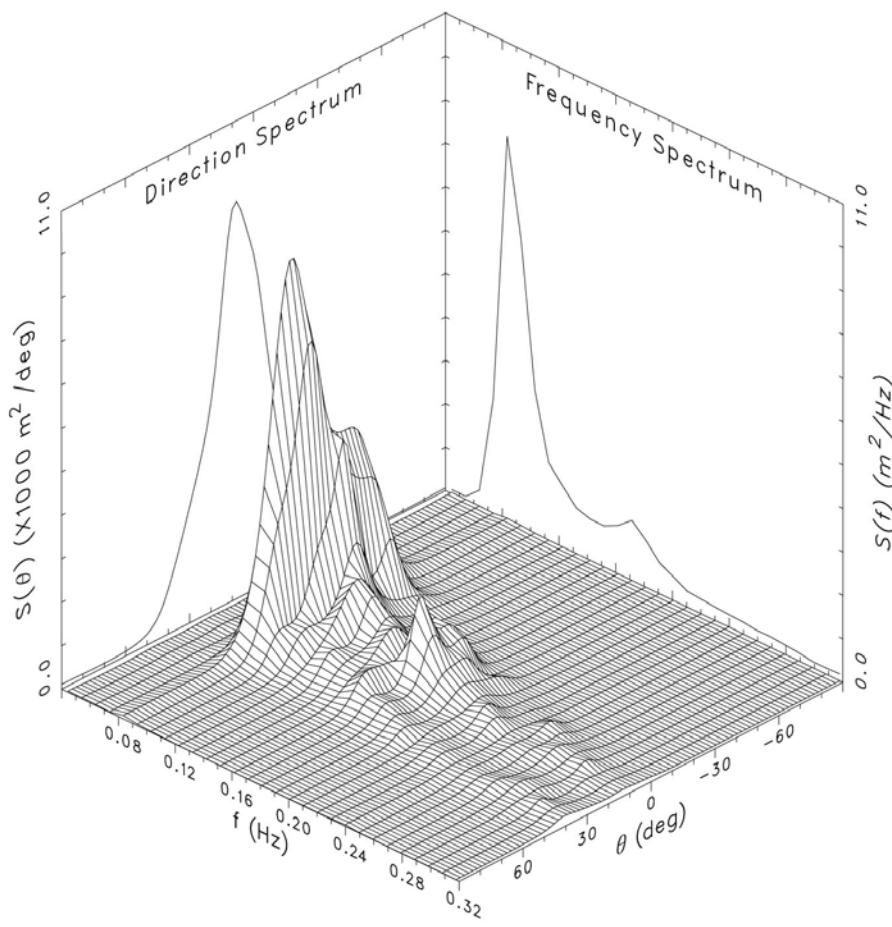


Input Parameters

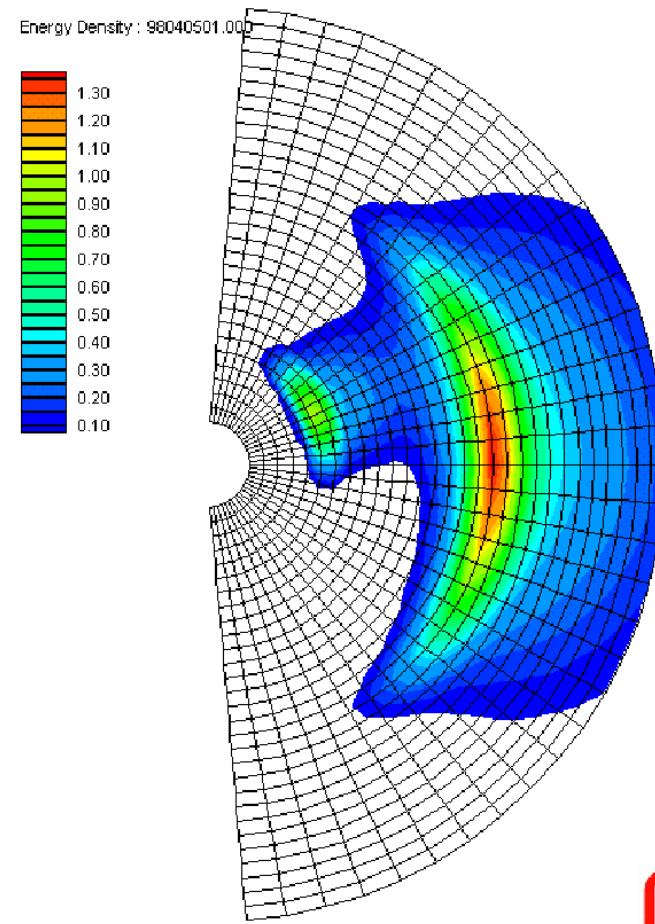
- Source terms (wind)
- Currents
- Breaking fields
- Radiation stresses
- Special output points
- Boundary type



Input Spectrum



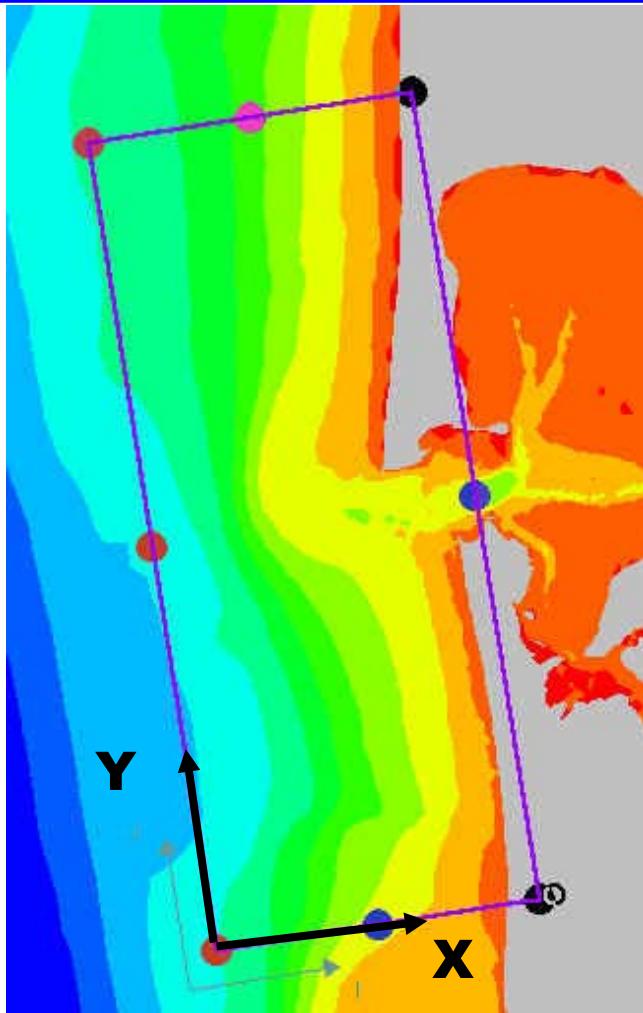
Navigation Program



Transformation-Scale Waves

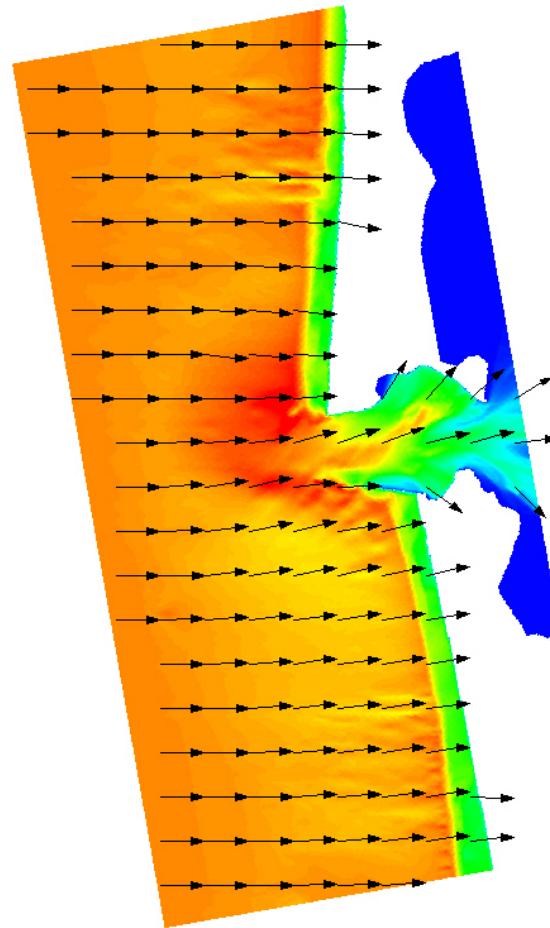
Input Bathymetry

Navigation
Program



Model Output

- Grid:
 - Height
 - Period
 - Direction
 - Radiation stress
 - Breaking indicator
- Selected locations:
 - Spectra
 - Nesting spectra





STWAVE Sessions

Navigation Program

- Tuesday 13:00-13:45
 - Model Parameters
- Wednesday 10:45-11:15
 - Optional Input
- STWAVE Report
 - <http://chl.wes.army.mil/research/wave/wavesprg/numeric/wtransformation/downld/erdc-chl-sr-01-11.pdf>
- Waves Web Page
 - <http://chl.wes.army.mil/research/wave/wavesprg/numeric/wtransformation/stwave.htm>

